Tomographic measurement of the phase-space distribution of a space-charge-dominated beam

Abstract:

Many applications of accelerators, such as free electron lasers, pulsed neutron sources, and heavy ion fusion, require a good quality beam with high intensity. In practice, a major limit on the achievable intensity is often determined by the dynamics at the low-energy end of the machine, which is dominated by space charge forces. Real laboratory beams at that low energy end are not in perfect equilibrium and a good understanding of their detailed evolution is needed. To address this issue, we give emphasis to the development of a simple and portable tomographic method to map the beam phase, which we extend to include effects from space charge. The technique makes no *a priori* assumptions of the beam distribution and is applicable to most machines. We simulate it using a particle in cell code, WARP, to ascertain accuracy of the reconstruction. Using this diagnostic we report a number of experiments conducted at the University of Maryland Electron Ring to examine emittance growth and charge homogenization of a beam with a transversely nonuniform initial density distribution. Our measurements are compared with results from theory and simulation.